Multiple Scenarios for Fisheries to Increase Potentially Toxin Producing Cyanobacteria Populations in Selected Oregon Lakes

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Introduction

The dominance of cyanobacteria, many of which produce toxins, in lakes is often associated with external loads of phosphorus from activities in the watersheds. However, we have identified multiple pathways in selected Oregon lakes whereby fisheries management activities play a crucial role in promoting cyanobacteria populations.

Hypotheses

The proliferation of cyanobacteria in freshwater environments is aided by increased availability of phosphorus. Phosphorus availability is increased by alteration of native food-webs, thus changing the trophic dynamics of nutrient cycling in lakes. Fisheries management can alter food webs numerous ways.

Methods

Several Oregon lakes were investigated through the use of paleolimnological techniques. Sediment cores were dated using ^{210}Pb and changes in water quality and cyanobacterial populations were examined using akinetes (resting cells) preserved in the sediments.

Results

Fish populations were shown to alter trophic structure and thus increase phosphorus availability in several ways. In Diamond Lake, the inadvertent introduction of a minnow (tui chub, *Gila bicolor*) native to an adjoining basin led to increased fish biomass and translocation of nutrients from the shallow waters to the pelagic zone. Diamond Lake was treated with rotenone in 1954, thus eliminating all fish and resulting in an immediate drop in cyanobacteria populations. The cyanobacteria densities in Diamond Lake have increased in recent years with the reintroduction of the tui chub and leading to lake closures. In Odell Lake, the State intentionally introduced kokanee (land-locked sockeye salmon, *Oncorhynuchus nerka*) to enhance a native salmonid fishery. The kokanee became the dominant fish and increased nutrient cycling by consuming large quantities of zooplankton in the metalimnion and recycling nutrients back into the photic zone. The native salmonids occupy the hypolimnion during the summer, providing relatively little opportunity for returning phosphorus back to the photic zone in the summer. Devils Lake is a shallow coastal lake with a native salmonid fishery and introduced centrarchids. In an effort to reduce the abundant macrophyte growth throughout much of the lake, the local lake district (with permission of the State) introduced triploid grass carp (*Ctenopharyngoden idella*). The stocking was successful and the grass carp eventually ate all submerged macrophytes in the lake. Once the macrophytes were eliminated, cyanobacterial populations increased dramatically most likely because of increased light availability, reduced competition for nutrients, and increased nutrient supply associated with disturbance of the sediment by the grass carp. Crane Prairie Reservoir is a shallow impoundment in central Oregon and historically was a rainbow trout fishery. It currently has five introduced, non-native fish species and is experiencing major blooms of cyanobacteria.

Conclusions

Fish management activities can increase the likelihood of cyanobacterial blooms through a variety of mechanisms involving translocation of nutrients, increased retention of nutrients in the photic zone, substrate disturbance, and reduction of large cladoceran zooplankton.